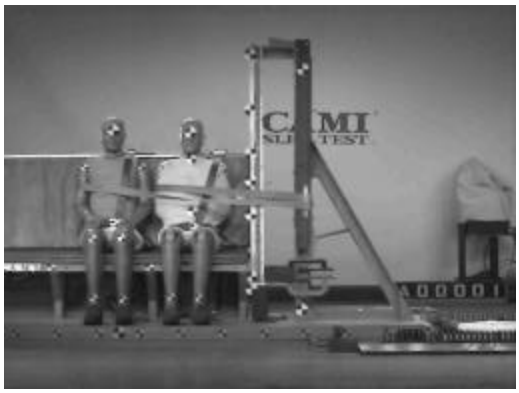
LAACO DER Conference
September 2000
Multiple Occupant Side Facing Seats (Divans)



Stephen Soltis - FAA NRS Crash Dynamics

Side Facing Seats

STATEMENT OF ISSUE:

Side-facing seats are considered a novel design for Transport Category Airplanes that include amendment 25-64 in the certification basis, and were not considered when those airworthiness standards were promulgated.

The FAA has determined that the existing regulations do not provide adequate or appropriate safety standards for occupants of side-facing multiple occupant seats (divans).

Additionally the best criteria currently available for evaluation of this type of seating do not ensure a level of safety that is equivalent to that afforded to occupants of forward and aft facing seating.

Side Facing Seats

STATEMENT OF ISSUE:

The only certification method available for this type of seating, for aircraft that include Amendment 25-64 in their certification basis, is through an exemption.

Issue papers will be used to establish the minimum acceptable testing and human injury criteria that will be applied to side-facing divan certifications.

Aircraft Vs Automotive Side Impact

- *No structure intrudes the side of occupant(s)*
- *Nature of occupant-to-occupant contact is different*
- *Occupants are exposed to much slower rate of chest and rib compression, but for a longer period*

Side Facing Seats

The Proposed Injury Criteria

Existing Criteria: All injury protection criteria of § 25.562(c)(1) through (c)(6) apply to the occupants of side-facing seating. Head injury criterion (HIC) assessments are only required for head contact with the seat and/or adjacent structures.

Body-to-body contact: Contact between the head, pelvis, or shoulder area of one Anthropomorphic Test Dummy (ATD) on the adjacent seated ATD's is not allowed during the tests conducted in accordance with §§ 25.562(b)(1) and (b)(2).

Incidental contact of the legs, feet, arms and hands that will not result in incapacitation of the occupants is acceptable. Contact during rebound is allowed.

Side Facing Seats

The Proposed Injury Criteria

Body-to-wall/furnishing contact: If the divan is installed aft of a structure, such as an interior wall or furnishing, that may be contacted by the pelvis, upper arm, chest, or head of an occupant seated next to the structure, a conservative representation of the structure and its stiffness must be included in the tests.

In most cases the representation of the structure would be more rigid and have less deflection under load than the actual airplanes installation.

The contact surface of this structure must be covered with at least two inches of energy absorbing protective foam, such as ensolite.

Side Facing Seats

The Proposed Injury Criteria

Thoracic Trauma: Testing with a Side Impact Dummy (SID), as defined by 49 CFR Part 572, Subpart F, or its equivalent, must be conducted and Thoracic Trauma Index (TTI) injury criteria acquired with the SID must be less than 85, as defined in 49 CFR Part 572, Subpart F.

SID TTI data must be processed as defined in Federal Motor Vehicle Safety Standard (FMVSS) Part 571.214, section S6.13.5.

$$TTI(d) = \tfrac{1}{2}\,(RIB_G + T12_G)$$

Side Facing Seats

The Proposed Injury Criteria

Pelvis: Pelvic lateral acceleration must not exceed 130g. Pelvic acceleration data must be processed as defined in FMVSS Part 571.214, section S6.13.5.

Shoulder Strap Loads: Where upper torso straps (shoulder straps) are used for divan occupants, tension loads in individual straps must not exceed 1,750 pounds.

If dual straps are used for restraining the upper torso, the total strap tension loads must not exceed 2,000 pounds.

Side Facing Seats

General Conditions

All side-facing seats require end closures or other means, to prevent the occupant from translating off of the seat.

All seat positions need to be occupied for the longitudinal tests.

Side Facing Seats

General Conditions

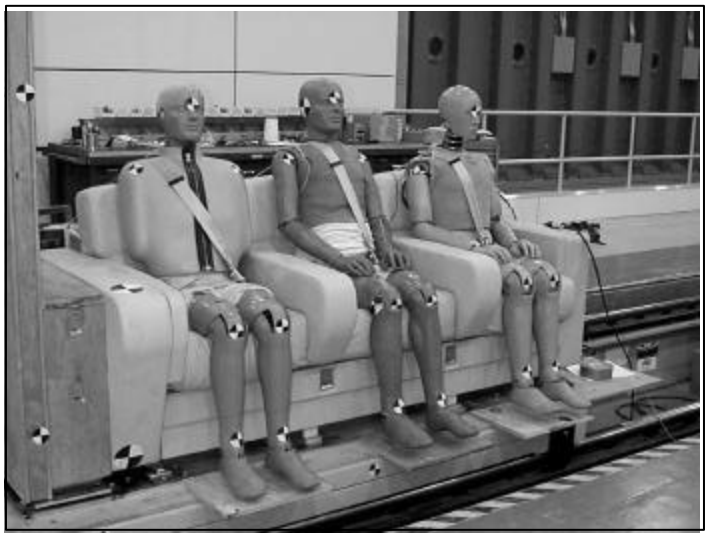
For the longitudinal tests, conducted in accordance with the conditions specified in § 25.562(b)(2), a minimum of two tests will be required, as follows:

One test will be required with ATD's in all positions, with undeformed floor, 10 degrees yaw, and with all lateral supports (armrests/walls).

For configurations with a wall or bulkhead immediately forward of the forward seat position on the divan a SID ATD will be used in the forward seat position and all other seat locations Hybrid II ATD(s) or equivalent will be used.

For configurations without a wall or bulkhead immediately forward of the forward seat Hybrid II ATDs or equivalent will be used in all seat locations.

Example of Test Setup



Side Facing Seats

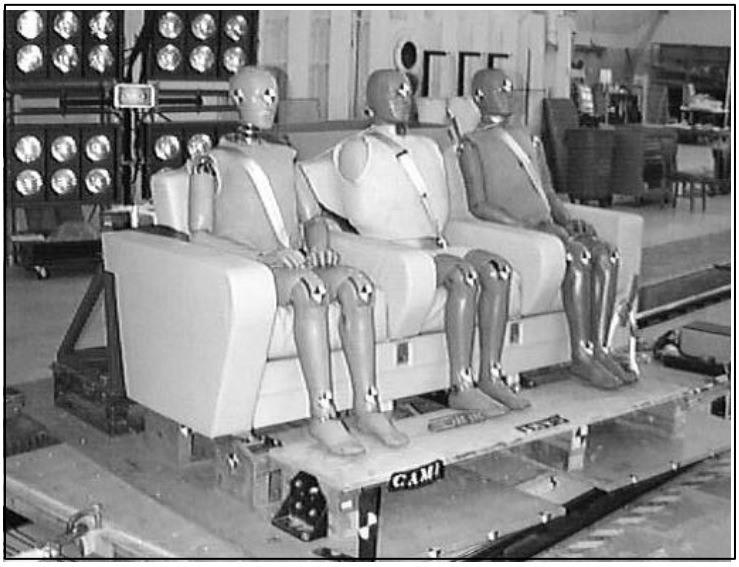
General Conditions

For the longitudinal tests, conducted in accordance with the conditions specified in § 25.562(b)(2), a minimum of two tests will be required, as follows:

Another test will be required with one SID ATD in the center seat and Hybrid II ATD(s) or equivalent in all other positions, with deformed floor, 10 degrees yaw, and with all lateral supports (armrests/walls).

This could be considered the structural test as well.

Example of Test Setup



Side Facing Seats

General Conditions

For the vertical test, conducted in accordance with the conditions specified in § 25.562(b)(1):

Hybrid II ATD's or equivalent will be used in all seat positions.

Other NRS Proposed Criteria - Neck injury

Based on a review of a number of data references and the latest NHTSA rulemaking action the following candidate human neck injury criteria are recommended:

Neck loads to be measured at the upper neck load cell:

Lateral neck moment (Mx) not to exceed 487 inch-pounds.

Lateral neck shear (Fy) not to exceed 697 pounds.

Peak tension force (Fz) not to exceed 937 pounds.

Peak compressive force (Fz) not to exceed 899 pounds.

Ref. 49 CFR Part 552 et al, Federal Motor Vehicle Safety Standards; Occupant Crash Protection; Final Rule, 65 FR 30680, May 12, 2000.

Other NRS Proposed Criteria - Neck injury

Based on a review of a number of data references and the latest NHTSA rulemaking action the following candidate human neck injury criteria are recommended:

Neck loads to be measured at the upper neck load cell:

$$Nij = (Fz/Fzc) + (Mx/Mxc) < 1.0$$

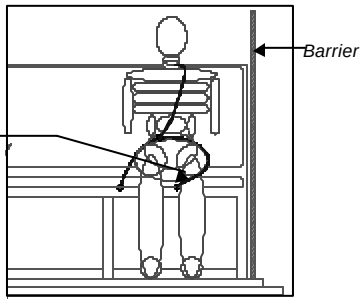
Where:

Fzc = 1530 lbs when Fz is tension
Fzc = 1385 lbs when Fz is compression
Mxc = 487 in-lbs

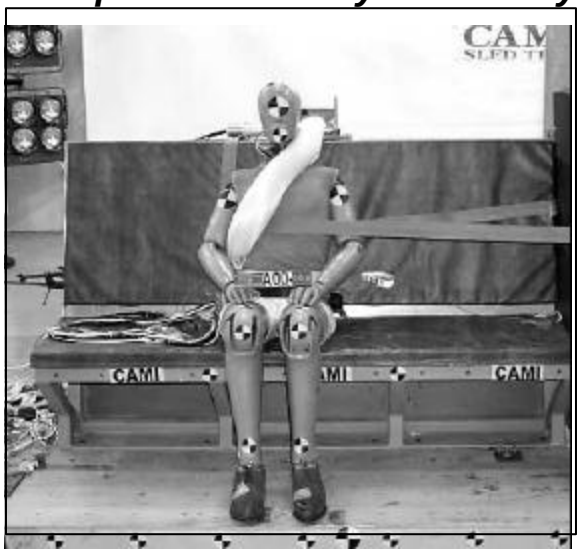
Ref. 49 CFR Part 552 et al, Federal Motor Vehicle Safety Standards; Occupant Crash Protection; Final Rule, 65 FR 30680, May 12, 2000.

Research Activities Continue
Example Restraint System Study

- *Body-centered belt*
  - *Forward lap belt was anchored behind the pelvis*
  - *Shoulder anchorage centered behind the neck*



Research Activities Continue
Example Restraint System Study



LAACO DER Conference

September 2000

Plinths, Pallets, and Adapter Plates

Presented by: Stephen Soltis
FAA National Resource Specialist for Crash Dynamics

Plinths, Pallets, and Adapter Plates

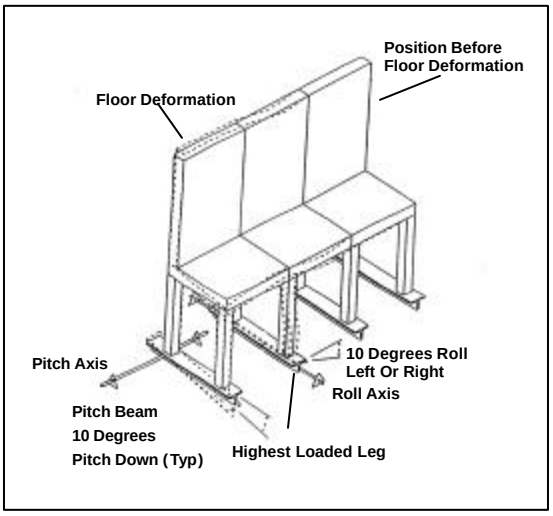
Background: Basis of Far 25.562

For transport category airplanes FAR 25.562 is based on a match of the seat dynamic strength and airframe static strength (Ref. 25.561).

For transport category airplanes the local seat track strength (lips) and the seat track bending strength are matched by design.

That's the rationale for allowing a FAR 25.562 dynamic test with only a representation of the local seat track strength (i.e., floor track segment).

Illustration of FAR 25.562 Seat Dynamic Test Floor Warpage - Multiple Leg Seat



Plinths, Pallets, and Adapter Plates

Background: Basis of Far 25.562

Plinths/pallets/adapter plates were not considered in the decision process that led to conduct of the dynamic test with only a representation of the local seat track strength (i.e., floor track segment).

FAR 25.562 tests cannot ensure that the cabin floor can react the plinth/pallet/adapter plate floor interface loads when dynamic tests are conducted with only a seat track segment.

The plinth/pallet/adapter plate installation may induce a mismatch between the local seat track strength (lips) and the seat track bending strength.

Business Jet Customers Demand Unique Interiors

Seats and other interior components may not be located above aircraft floor attachment structure and adapter plates may need to be used to install those items.

Overview of Existing Policy Memorandum

Memorandum

U.S. Department of Transportation
Federal Aviation Administration

Subject: INFORMATION: Acceptable Interim Approach for Multiple Single-Place Seats Mounted to an Adapter-Plate

Date: MAY 1 2007

From: Manager, Transport Standards Staff
Transport Airplane Directorate,
Aircraft Certification Service, ANM-100

Reply to Attn. of: 00-115-7

to: SEE DISTRIBUTION LIST

The purpose of this memorandum is to transmit acceptable interim means to demonstrate compliance with § 25.562 of the FAR for seats installed on adapter plates, sometimes referred to as "planks" or "pallets".

The attachment addresses a specific type of installation, for which the guidance contained in Advisory Circular 25.562-1, as clarified by memorandum 00-115-3, may not provide sufficient information. Recent installations of multiple single-place seats onto adapter plates, with the adapter plate installed into the airplane seat track (or other structure), have generated questions as to the proper certification procedure. In these cases, no dynamic testing incorporating the adapter plates was performed. The attached guidance addresses that issue.

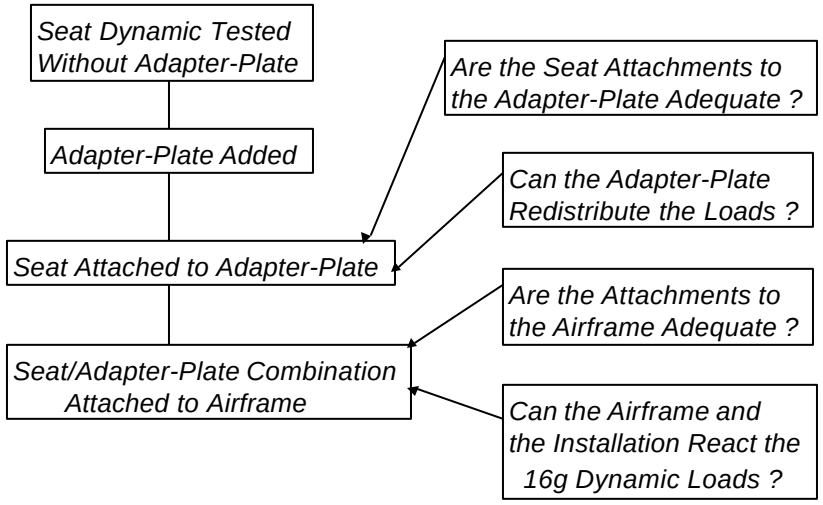
This guidance is interim, because additional data are needed to assess the interaction of seats/adapter plates/airframe. However, there are very near term projects where certification criteria are required before such data will be available. This guidance may be used until the FAA publishes a superseding document(s).

Any questions may be directed to Jeff Gardlin at (425)227-2136 or Greg Schneider at (425)227-2116.

Dorenda D. Baker

Attachment

Issue: ***The load path between the seat and aircraft floor structure must be shown to be capable of transferring the 16g seat dynamic loads.***



Multiple Single Seats Mounted to an Adapter Plate

Acceptable Interim Means of Compliance to § 25.562

For the load path components between the seat leg attachments and the aircraft seat track or floor fittings, which were not represented/substantiated in the l6g dynamic seat test, a stress analysis of those details, using the peak loads recorded during the l6g dynamic tests, may be performed as <u>an acceptable interim means</u> of compliance to § 25.562 (b).

Multiple Single Seats Mounted to an Adapter Plate

Conditions Necessary to Use the Interim Approach

Each seat type (without adapter) has been dynamically tested in accordance with § 25.562, including pitch and roll.

The tested means of attachment is consistent with attachment of the seat to the adapter-plate.

Compliance with § 25.561 is achieved.

Multiple Single Seats Mounted to an Adapter Plate

Conditions Necessary to Use the Interim Approach

Airplane floor warpage is addressed for the adapter-plate installation by providing an adequate number of distributed attachments of the adapter-plate to the airplane floor structure.

The number of attachments will depend on the design of the adapter-plate and positioning of the seats on the plate. Typically the number of attachments will exceed the number of seat-to-adapter-plate attachments and shall not be less than the number of seat-to-adapter-plate attachments.

The attachments of the adapter-to-aircraft structure must be structurally adequate to accommodate the dynamic loads and floor deformation.

Multiple Single Seats Mounted to an Adapter Plate

Conditions Necessary to Use the Interim Approach

If the actual attachment of the seat to the adapter-plate was not represented during the l6g dynamic seat test, it must be shown that the retention of the seat to the adapter-plate will not be compromised when the seat legs are subjected to the required pre-test pitch and roll conditions of § 25.562(b)(2).

Testing of this condition may not be necessary if the attachment retention design and strength are shown to be capable of accommodating the dynamic loads and deformations.

Multiple Single Seats Mounted to an Adapter Plate

Analysis of Load Path Components Not Tested

<u>Analysis of the seat-to-adapter-plate interface:</u> It must be shown that the seat/plate attachment is capable of reacting the measured peak l6g seat loads. The analysis must take into account eccentricities of load path and adapter-plate deformations that may induce prying (bending) loads at the attachment.

NOTE: If a positive margin of safety cannot be achieved in the above analysis, either testing of the seat with the adapter-plate or redesign of the deficient interfaces will be required for compliance to § 25.562.

Multiple Single Seats Mounted to an Adapter Plate

Analysis of Load Path Components Not Tested

<u>An analysis of the adapter-plate:</u> It must be shown that the adapter-plate is capable of transferring the measured 16g peak loads from the seat-to-adapter-plate interface to the interface of the adapter-plate-to-aircraft floor structure (i.e., seat track lips and "hard points").

NOTE: If a positive margin of safety cannot be achieved in the above analysis, either testing of the seat with the adapter-plate or redesign of the deficient interfaces will be required for compliance to § 25.562.

Multiple Single Seats Mounted to an Adapter Plate

Analysis of Load Path Components Not Tested

<u>Analysis of the adapter-plate-to-aircraft-floor-structure interface:</u> The aircraft seat track lips must be shown to be capable of reacting the measured peak 16g seat test load as distributed by the adapter-plate from the seats.

The analysis must take into account eccentricities of load path and adapter-plate deformations that may induce prying (bending) loads at the attachment.

In the case of hard point installations, the interface would be taken to the point at which the hard point interfaces with the aircraft floor structure (e.g., floor beam).

NOTE: If a positive margin of safety cannot be achieved in the above analysis, either testing of the seat with the adapter-plate or redesign of the deficient interfaces will be required for compliance to § 25.562.

Multiple Single Seats Mounted to an Adapter Plate

Actual Seat/Plate/Aircraft-Floor Structure Test

If the actual seat/plate/aircraft-floor structure installation is planned to be tested, but the rigidity of the adapter-plate precludes the pre-test floor deformation condition from being performed, segments of the adapter-plate can be used for the interface between the seat and aircraft seat track section.

This is in lieu of using the full plate.

Multiple Single Seats Mounted to an Adapter Plate

Future Policy Statement

The FAA is also preparing a policy statement on the broader issue of compatibility of the seat installation with the airframe.

This future policy statement will address this issue, and others, where there may be a question of the dynamic performance of the seat producing loads that exceed the structural capability of the airframe.